CLAIMS

We claim:

- 1. In a database system, a method of maintaining a self-tuning histogram having a plurality of existing buckets arranged in a hierarchical manner and defined by at least two bucket boundaries, a bucket volume, and a bucket frequency comprising the step of creating at least one new bucket in response to a query on the database wherein each new bucket is contained within at least one existing bucket and wherein the new bucket becomes a child bucket and the existing bucket becomes a parent bucket.
 - 2. The method of claim 1 wherein each bucket has a rectangular shape.
- 3. The method of claim 1 wherein the boundaries of each new bucket correspond to a region of the database accessed by the query and the frequency of each new bucket is a number of data records returned by the query.
- 4. The method of claim 1 wherein a total number of buckets is limited to a predetermined budget.
- 5. The method of claim 4 comprising the step of merging buckets based on a merge criterion when the total number of buckets exceeds the predetermined budget.
- 6. The method of claim 5 wherein the merge criterion is a similar bucket density, wherein bucket density is based on the bucket frequency divided by the bucket volume.
- 7. The method of claim 1 further comprising the step of shrinking the boundaries of each new bucket if the boundaries of the new bucket intersect any existing bucket boundaries.

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- 8. The method of claim 1 wherein the frequency of the parent bucket is diminished by the frequency of the child bucket.
- 9. In a database system, a method of maintaining a self-tuning histogram having a plurality of existing buckets arranged in a hierarchical manner and defined by at least two bucket boundaries, a bucket volume, and a bucket frequency comprising the steps of:
 - a) examining the results of a query executed on the database;
- b) creating at least one candidate hole in the histogram based on the results of the query;
- c) modifying each candidate hole such that the modified hole is completely contained within at least one existing parent bucket and does not partially intersect any existing bucket; and
- d) creating a new child bucket in the histogram corresponding to each modified hole.
 - 10. The method of claim 9 wherein each bucket has a rectangular shape.
- 11. The method of claim 9 wherein the boundaries of each candidate hole correspond to a region of the database accessed by the query and the frequency of each candidate hole is a number of data records returned by the query.
- 12. The method of claim 9 wherein a total number of buckets is limited to a predetermined budget.
- 13. The method of claim 12 comprising the step of merging buckets based on a merge criterion when the total number of buckets exceeds the predetermined budget.

- 14. The method of claim 13 wherein the merge criterion is a similar bucket density, wherein bucket density is based on the bucket frequency divided by the bucket volume.
- 15. The method of claim 9 wherein the frequency of the parent bucket is diminished by the frequency of the child bucket.
- 16. A computer readable medium having computer executable instructions for performing steps for maintaining a self-tuning histogram having a plurality of existing buckets arranged in a hierarchical manner and defined by at least two bucket boundaries, a bucket volume, and a bucket frequency, the steps comprising:
 - a) examining the results of a query executed on the database;
- b) creating at least one candidate hole in the histogram based on the results of the query;
- c) modifying each candidate hole such that the modified hole is completely contained within at least one existing parent bucket and does not partially intersect any existing bucket; and
- d) creating a new child bucket in the histogram corresponding to each modified hole.
- 17. The computer readable medium of claim 16 wherein each bucket has a rectangular shape.
- 18. The computer readable medium of claim 16 wherein the boundaries of each candidate hole correspond to a region of the database accessed by the query and the frequency of each candidate hole it a number of data records returned by the query.

- 19. The computer readable medium of claim 16 comprising the step of merging buckets having a similar bucket density when the total number of buckets exceeds a predetermined budget.
- 20. An apparatus for maintaining a self-tuning histogram having a plurality of existing buckets arranged in a hierarchical manner and defined by at least two bucket boundaries, a bucket volume, and a bucket frequency comprising:
- a) means for examining the results of a query executed on the database;
- b) means for creating at least one candidate hole in the histogram based on the results of the query;
- c) means for modifying each candidate hole such that the modified hole is completely contained within at least one existing parent bucket and does not partially intersect any existing bucket; and
- d) means for creating a new child bucket in the histogram corresponding to each modified hole.
- 21. The apparatus of claim 20 wherein the means for creating at least one candidate hole assigns the boundaries of the candidate hole to correspond to a region of the database accessed by the query and the frequency of each candidate hole is assigned a number of data records returned by the query.

- 22. An apparatus for maintaining a self-tuning histogram having a plurality of existing buckets arranged in a hierarchical manner and defined by at least two bucket boundaries, a bucket volume, and a bucket frequency comprising:
- a) \ a memory device for storing a database comprising multiple data records;
- b) a computer having one or more processing units for executing a stored computer program, said computer including a rapid access memory store; and
- c) an interface for coupling the memory device for storing the database to the computer to allow records to be retrieved from the database; wherein
- d) the stored program has components including i) a component for examining the results of a query executed on the database; ii) a component for creating at least one candidate hole in the histogram based on the results of the query; iii) a component for modifying each candidate hole such that the modified hole is completely contained within at least one existing parent bucket and does not partially intersect any existing bucket; and iv) a component for creating a new child bucket in the histogram corresponding to each modified hole.
- 23. The apparatus of claim 22 wherein the component for creating at least one candidate hole assigns the boundaries of the candidate hole to correspond to a region of the database accessed by the query and the frequency of each candidate hole is assigned a number of data records returned by the query.